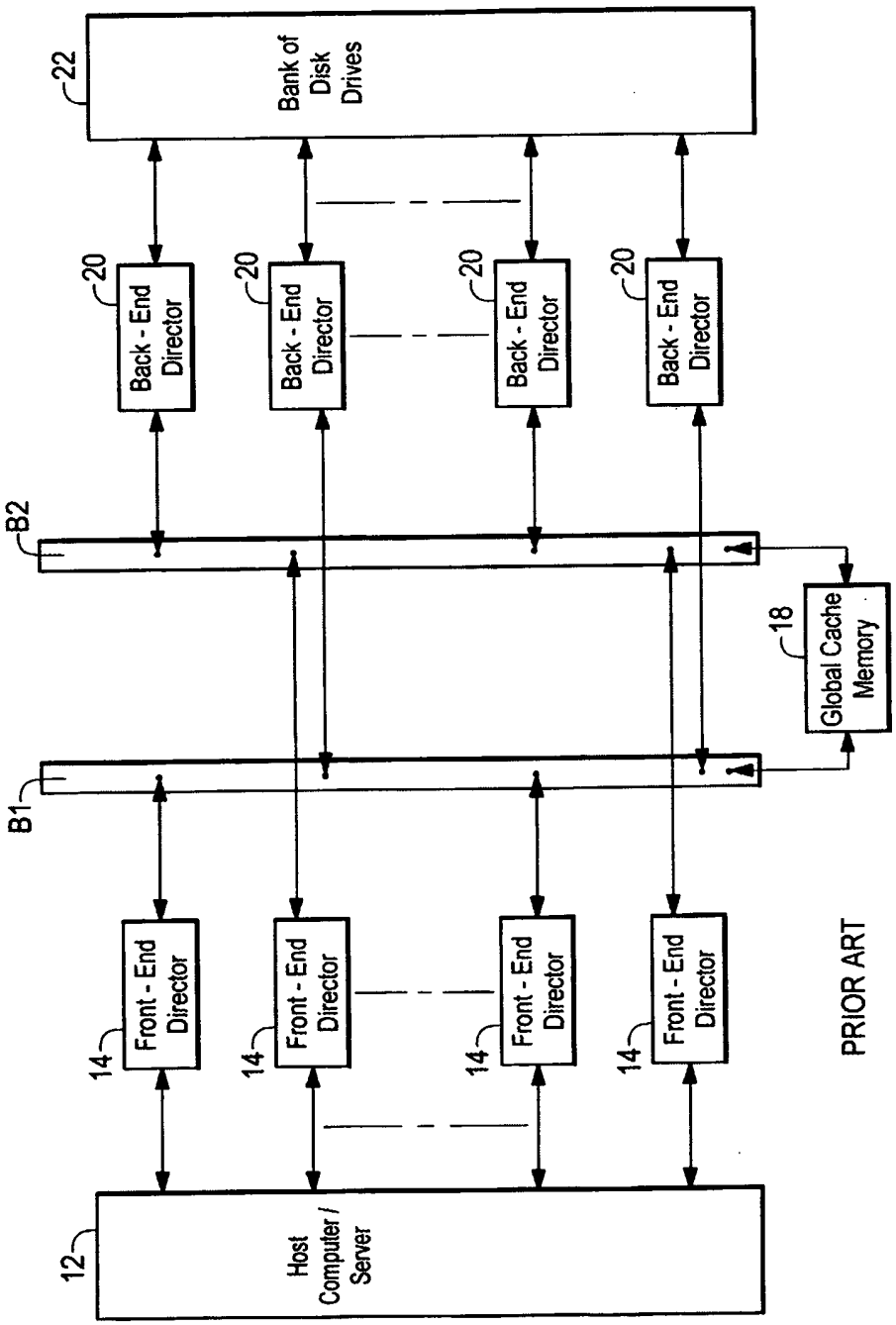


PRIOR ART

FIG. 1

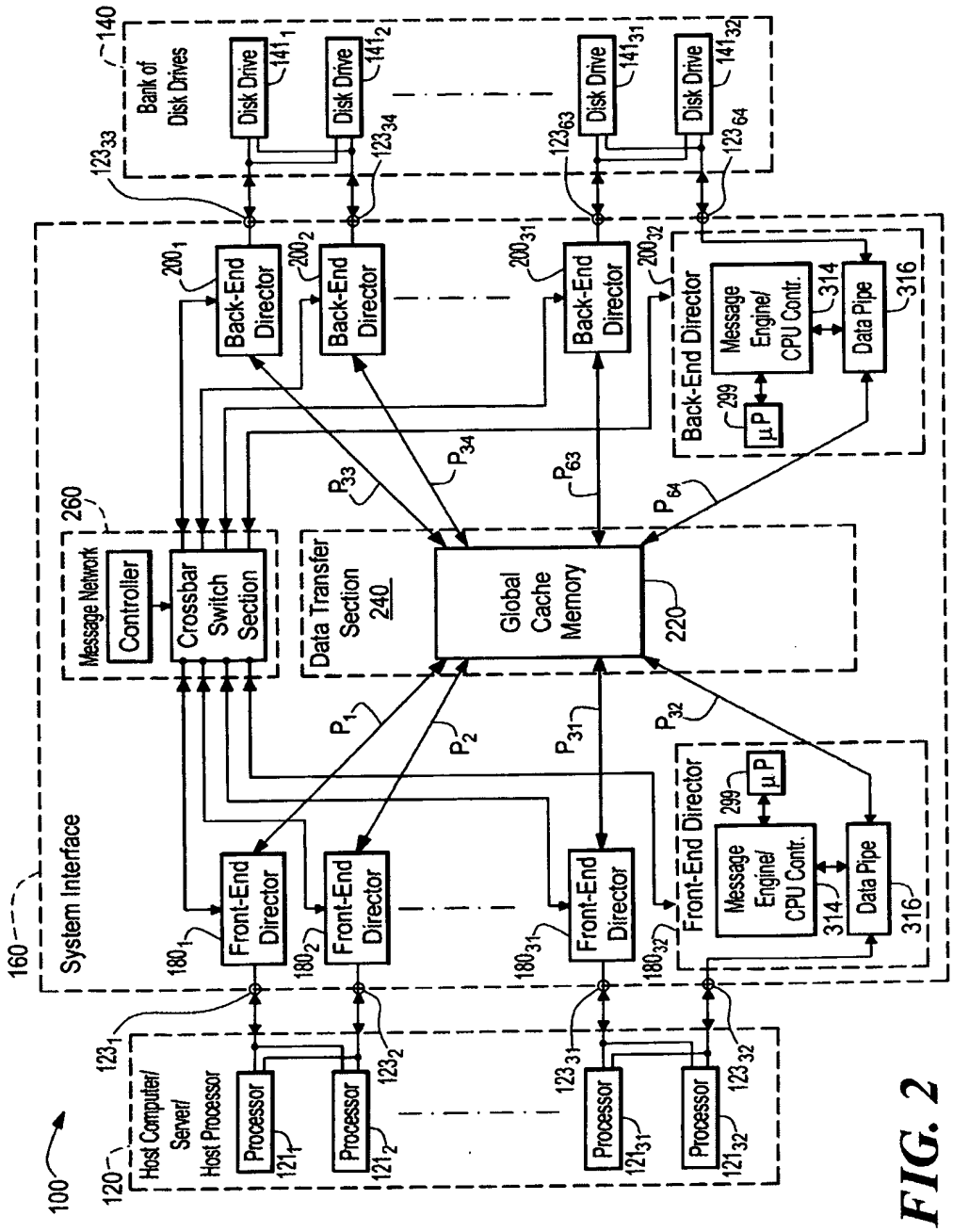

100
120
Host Computer/ Server/ Host Processor
Processor
121
123
160
System Interface
180
Front-End Director
Front-End Director
Front-End Director
Front-End Director
Message Engine/ CPU Contr.
299
μP
314
Data Pipe
316
260
Message Network
Controller
Crossbar Switch Section
Data Transfer Section 240
Global Cache Memory
220
P1
P2
P31
P32
P33
P34
P63
P64
200
Back-End Director
Back-End Director
Back-End Director
Back-End Director
Message Engine/ CPU Contr.
299
μP
314
Data Pipe
316
140
Bank of Disk Drives
Disk Drive
141

FIG. 2

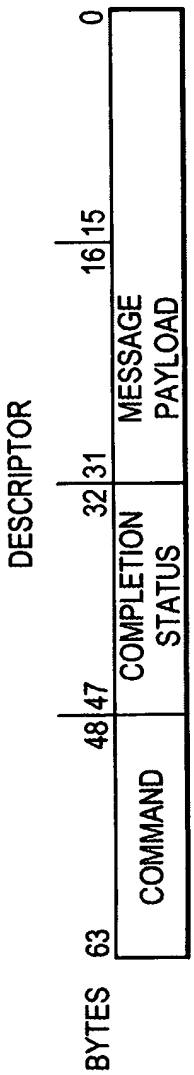

DESCRIPTOR
BYTES
63
48
47
32
31
16
15
0
COMMAND
COMPLETION STATUS
MESSAGE PAYLOAD

FIG. 2A

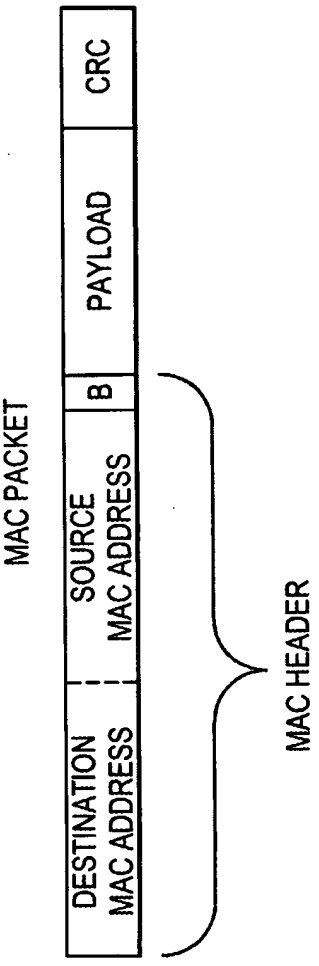
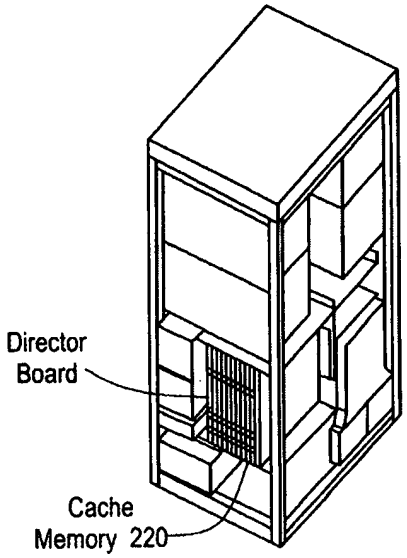

MAC PACKET
DESTINATION MAC ADDRESS
SOURCE MAC ADDRESS
B
PAYLOAD
CRC
MAC HEADER

FIG. 2B

FIG. 3


Director
Board
Cache
Memory 220

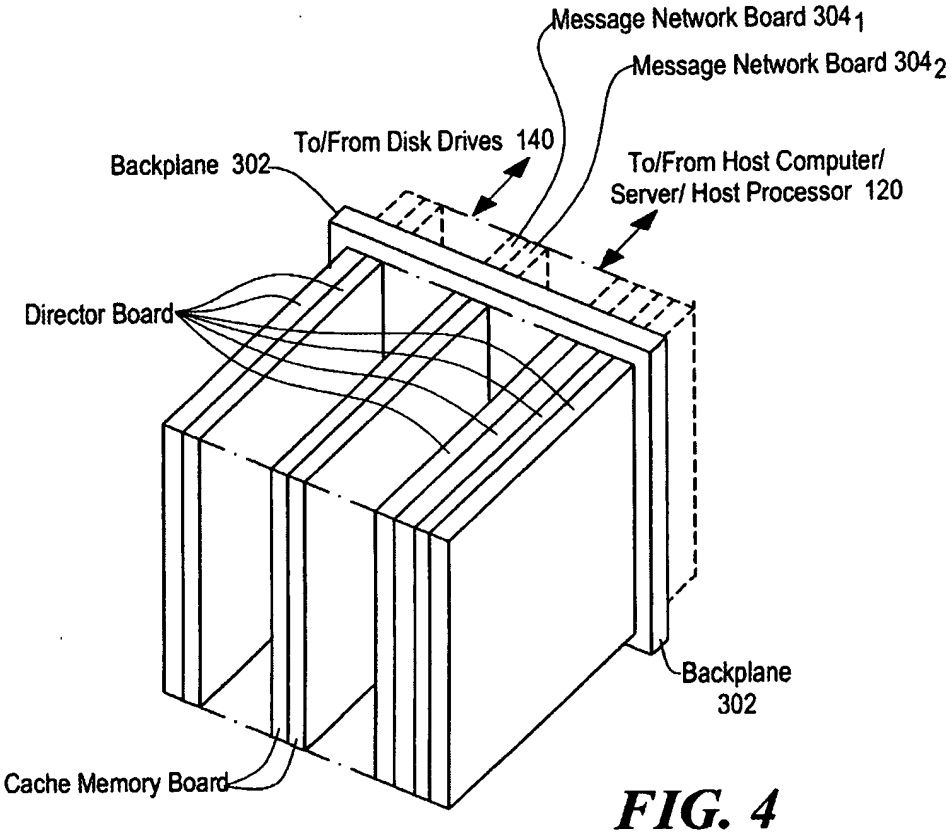
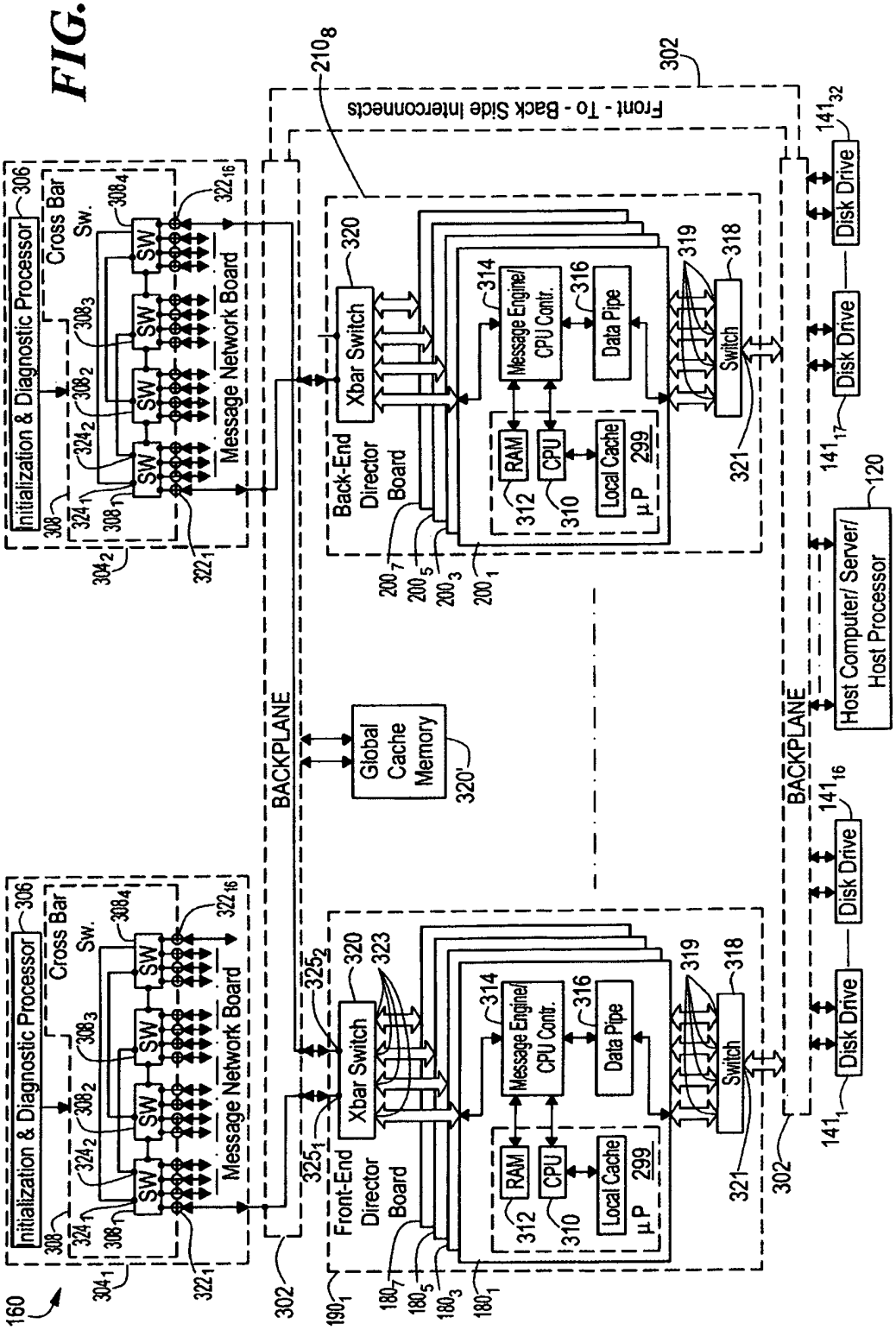

Message Network Board 304 1
Message Network Board 304 2
To/From Disk Drives 140
Backplane 302
To/From Host Computer/
Server/ Host Processor 120
Director Board
Backplane
302
Cache Memory Board

FIG. 4

FIG. 5


160
Initialization & Diagnostic Processor
306
Cross Bar Sw.
SW
Message Network Board
308
324
322
304
BACKPLANE
302
Front-End Director Board
190
180
Xbar Switch
320
323
325
Message Engine/ CPU Contr.
314
Data Pipe
316
319
318
Switch
321
RAM
312
CPU
310
Local Cache
µP
299
Global Cache Memory
320'
Back-End Director Board
200
Front - To - Back Side Interconnects
210
Host Computer/ Server/ Host Processor
120
Disk Drive
141

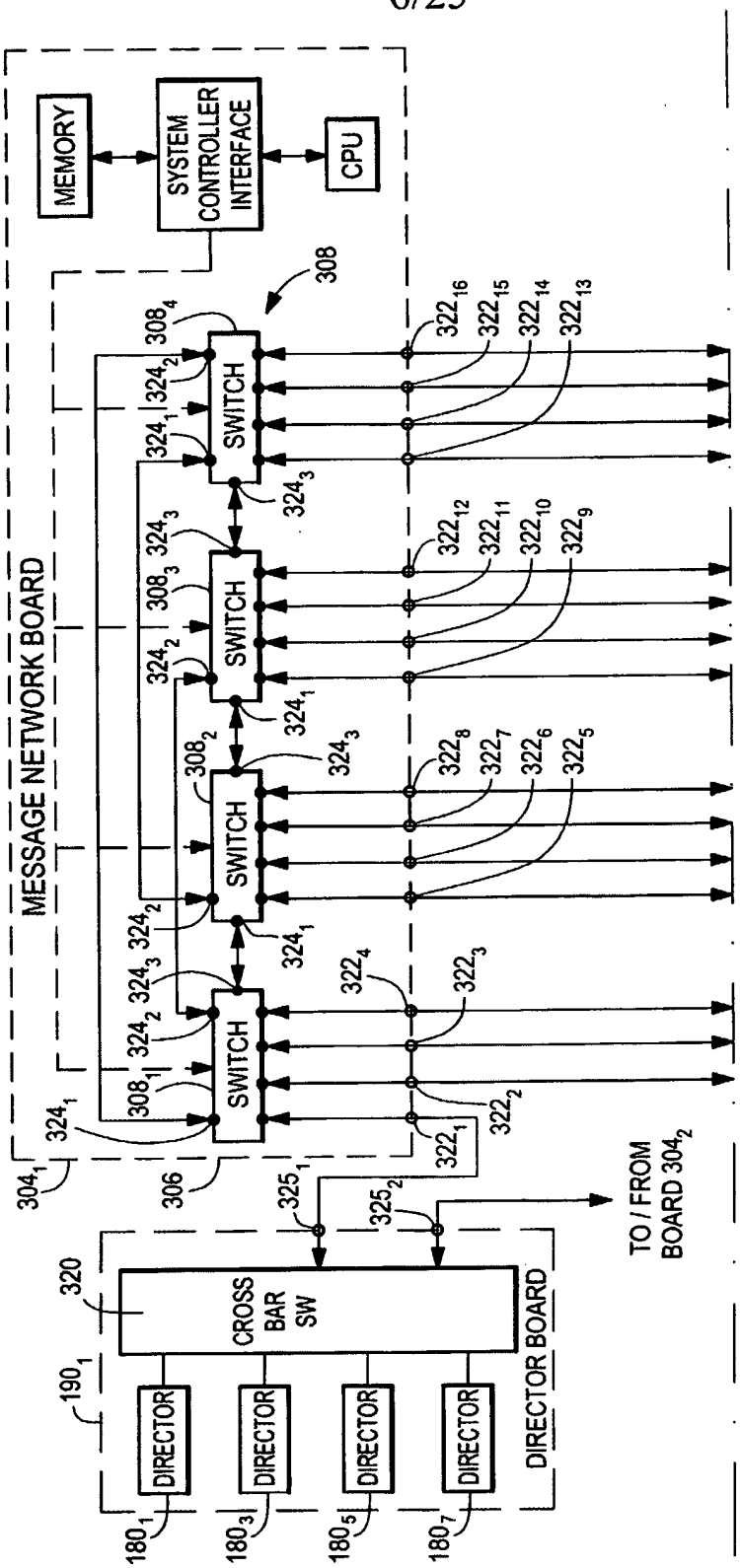

MEMORY
SYSTEM CONTROLLER INTERFACE
CPU
MESSAGE NETWORK BOARD
SWITCH
CROSS BAR SW
DIRECTOR
DIRECTOR BOARD
TO FIG. 6B
TO / FROM BOARD 304$_2$

FIG. 6A

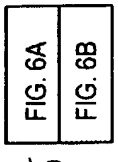
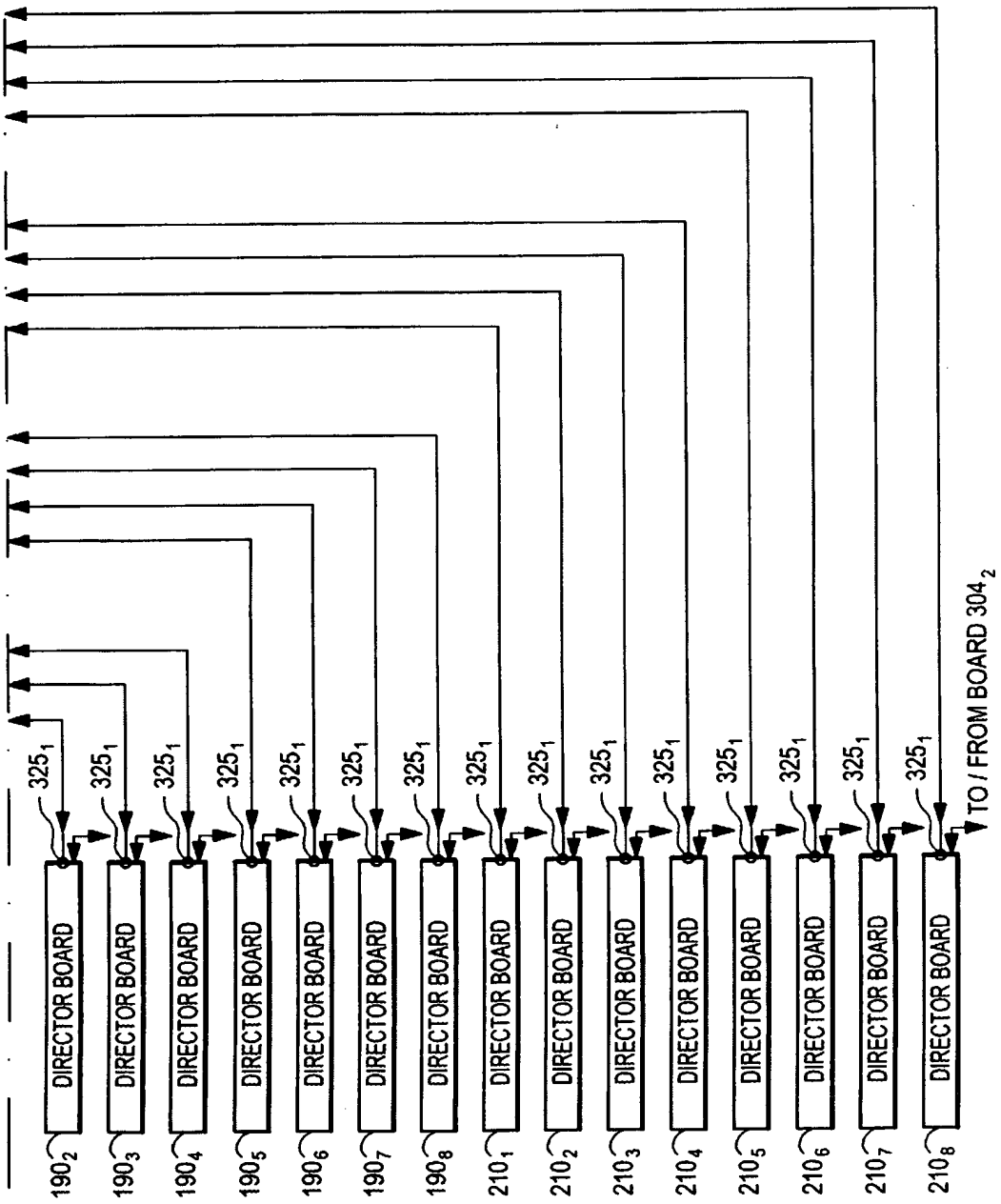


FIG. 6A
FIG. 6B

FIG. 6

FIG. 6B


FROM FIG. 6A
DIRECTOR BOARD
190_2
190_3
190_4
190_5
190_6
190_7
190_8
210_1
210_2
210_3
210_4
210_5
210_6
210_7
210_8
325_1
TO / FROM BOARD 304_2

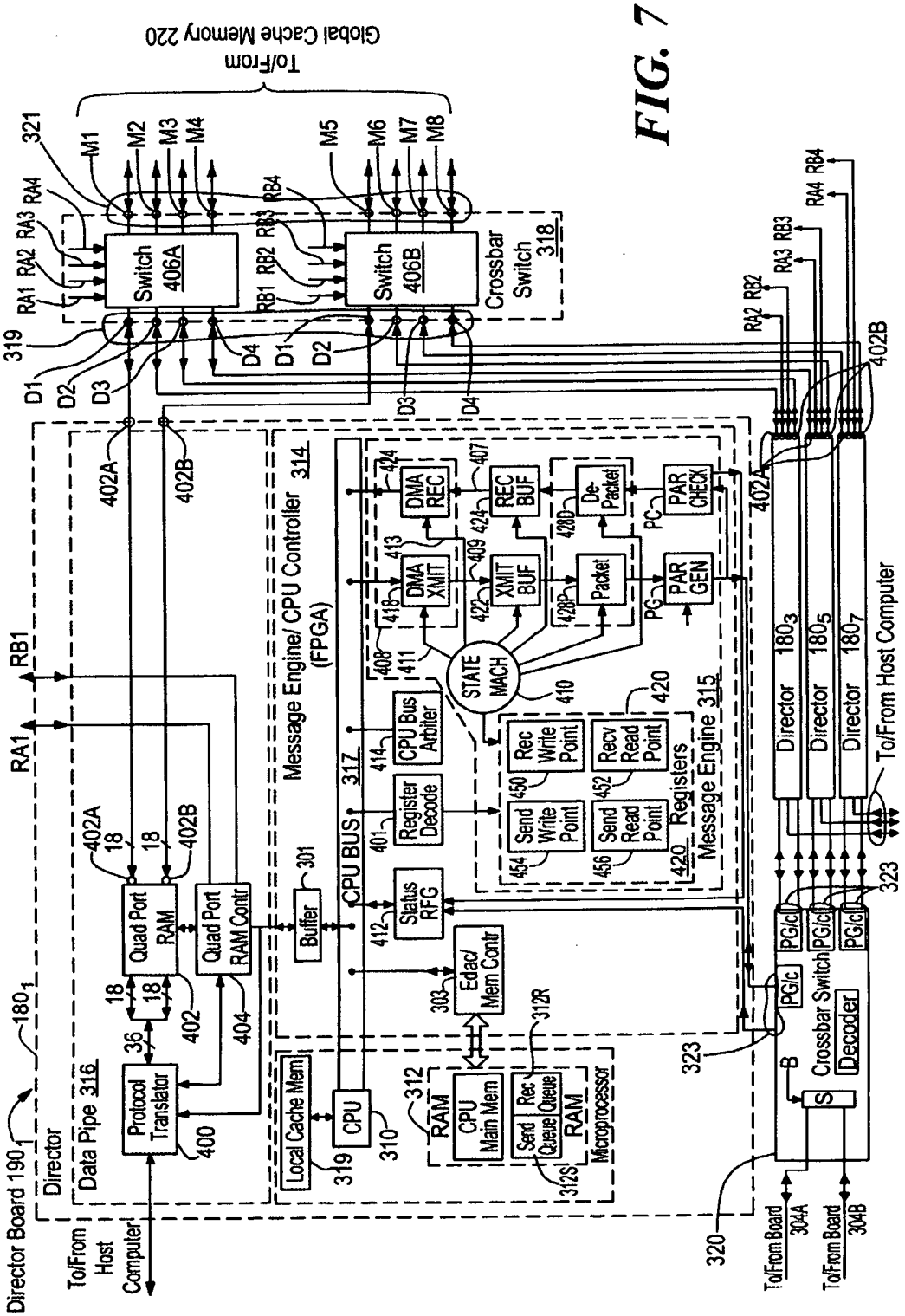

To/From Global Cache Memory 220
Crossbar Switch 318
Switch 406A
Switch 406B
Director Board 190
Director
Data Pipe 316
Protocol Translator
Quad Port RAM
Quad Port RAM Contr
Message Engine/ CPU Controller 314 (FPGA)
CPU BUS 317
CPU
Local Cache Mem
Buffer
Status RFG
Register Decode
CPU Bus Arbiter
Edac/ Mem Contr
RAM
CPU Main Mem
Send Queue
Rec Queue
Microprocessor
DMA REC
DMA XMIT
REC BUF
XMIT BUF
De-Packet
Packet
PAR CHECK
PAR GEN
STATE MACH
Message Engine 315
Registers
Rec Write Point
Recv Read Point
Send Write Point
Send Read Point
Director 180
Crossbar Switch
Decoder
PG/c
To/From Host Computer
To/From Host Computer
To/From Board 304A
To/From Board 304B

FIG. 7

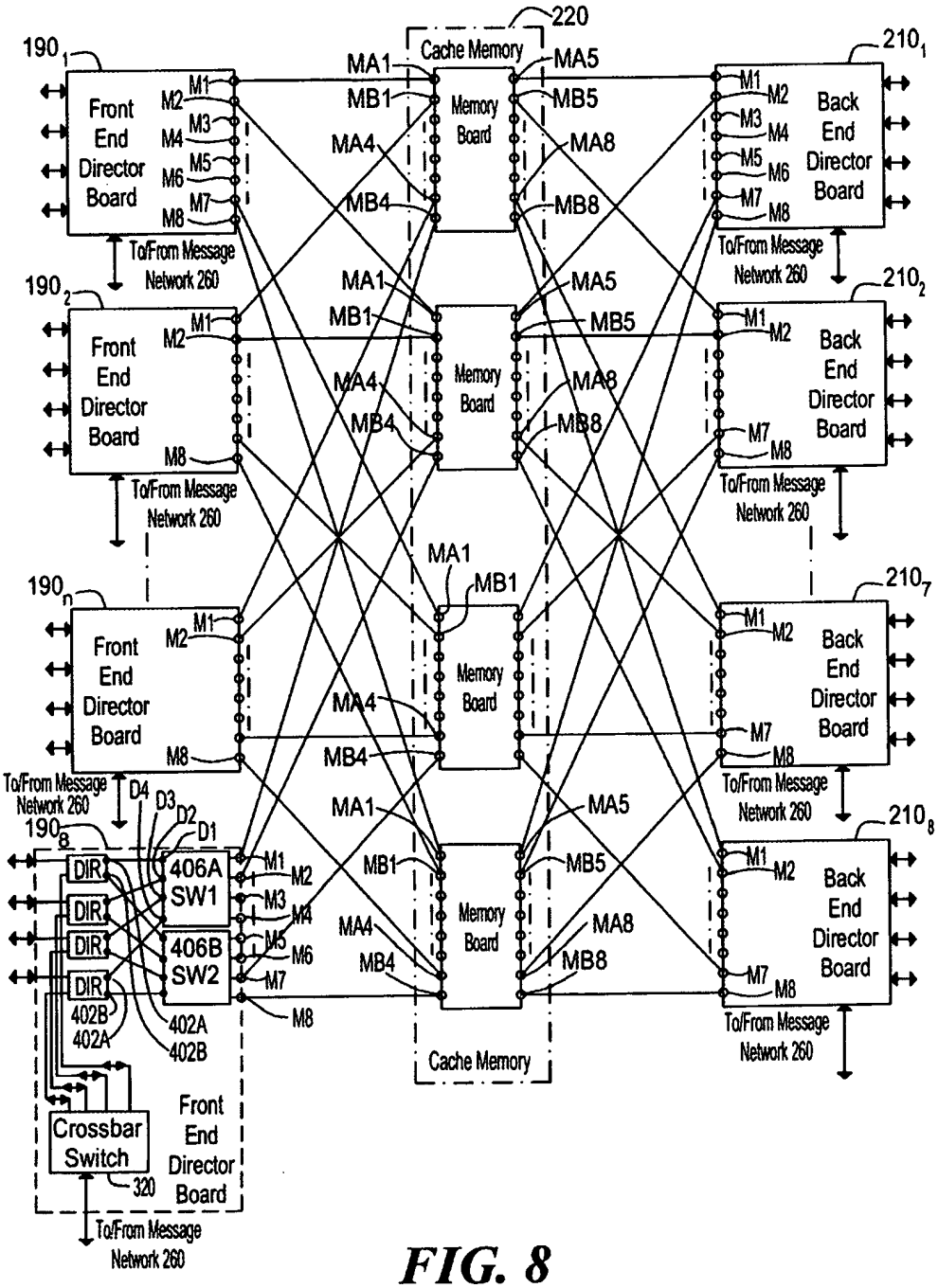

220
Cache Memory
190 1
Front End Director Board
M1 M2 M3 M4 M5 M6 M7 M8
To/From Message Network 260
190 2
190 n
190 8
DIR
406A SW1
406B SW2
D1 D2 D3 D4
402A 402B
Crossbar Switch
320
MA1 MB1 MA4 MB4 MA5 MB5 MA8 MB8
Memory Board
210 1
210 2
210 7
210 8
Back End Director Board

FIG. 8

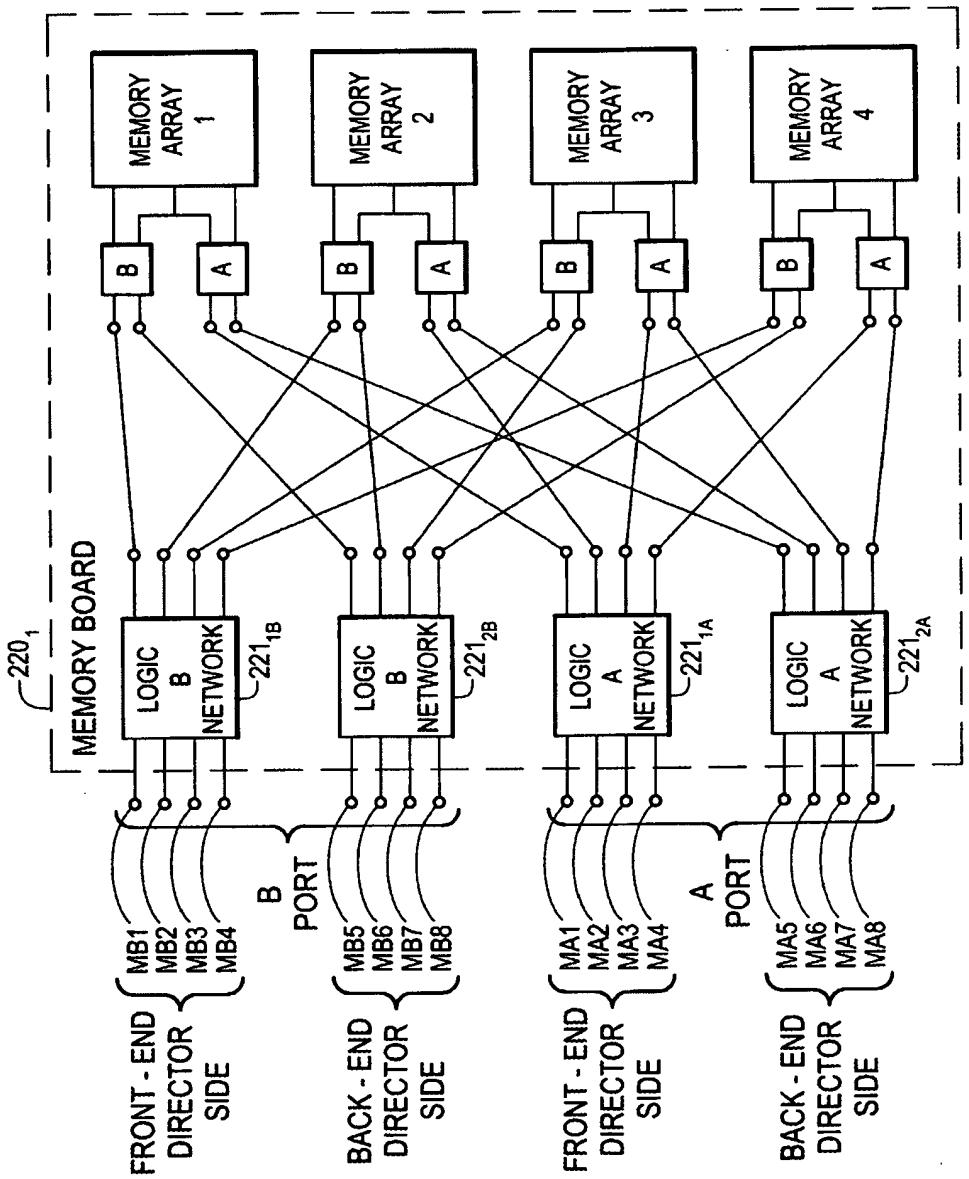

MEMORY BOARD
220_1
MEMORY ARRAY 1
MEMORY ARRAY 2
MEMORY ARRAY 3
MEMORY ARRAY 4
B
A
LOGIC B NETWORK
221_{1B}
LOGIC B NETWORK
221_{2B}
LOGIC A NETWORK
221_{1A}
LOGIC A NETWORK
221_{2A}
B PORT
A PORT
MB1
MB2
MB3
MB4
MB5
MB6
MB7
MB8
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
FRONT - END DIRECTOR SIDE
BACK - END DIRECTOR SIDE
FRONT - END DIRECTOR SIDE
BACK - END DIRECTOR SIDE

FIG. 8A

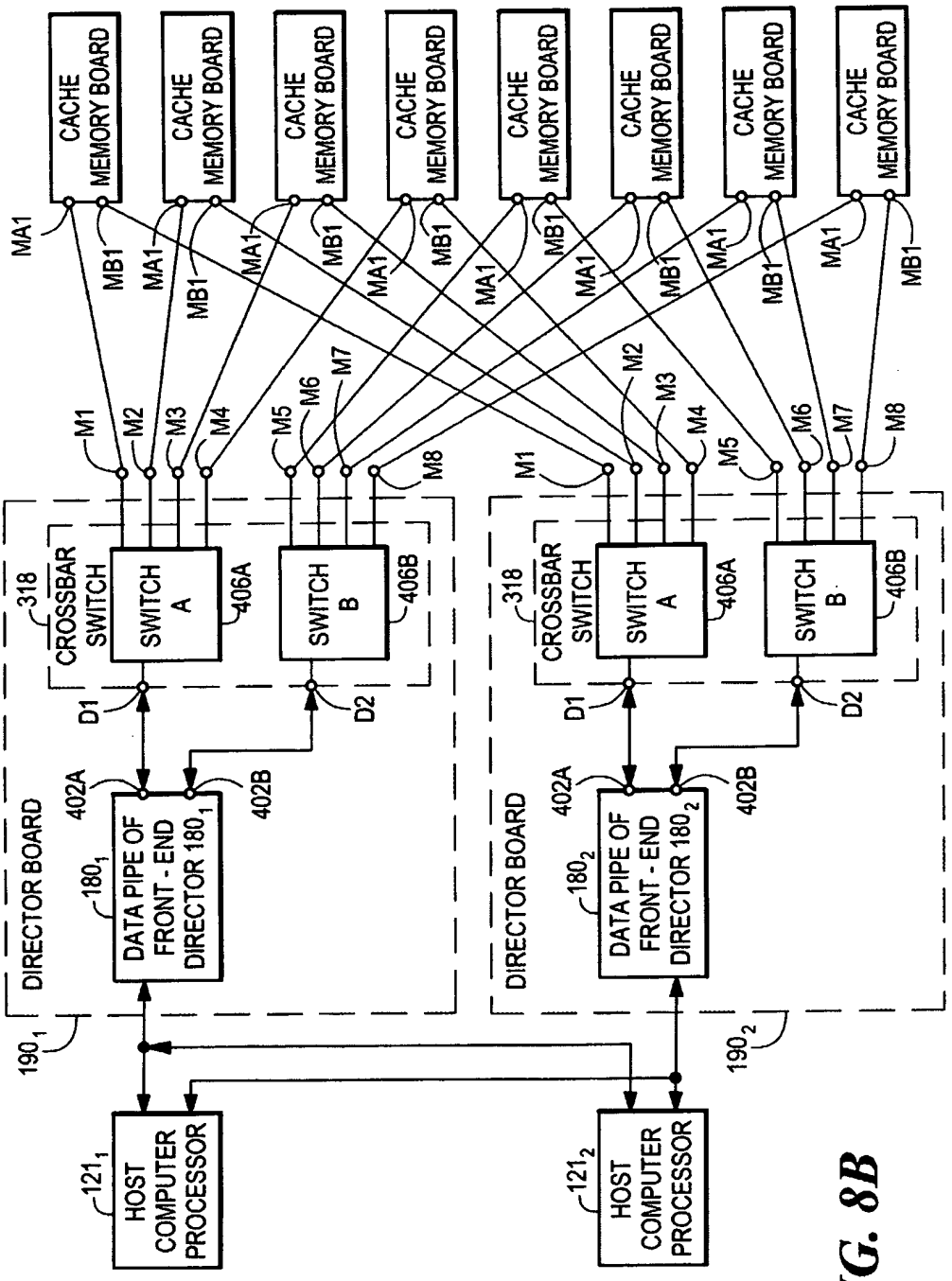

CACHE MEMORY BOARD
MA1
MB1
M1
M2
M3
M4
M5
M6
M7
M8
318
CROSSBAR SWITCH
SWITCH A
406A
SWITCH B
406B
D1
D2
402A
402B
DIRECTOR BOARD
DATA PIPE OF FRONT - END DIRECTOR 180
HOST COMPUTER PROCESSOR

FIG. 8B

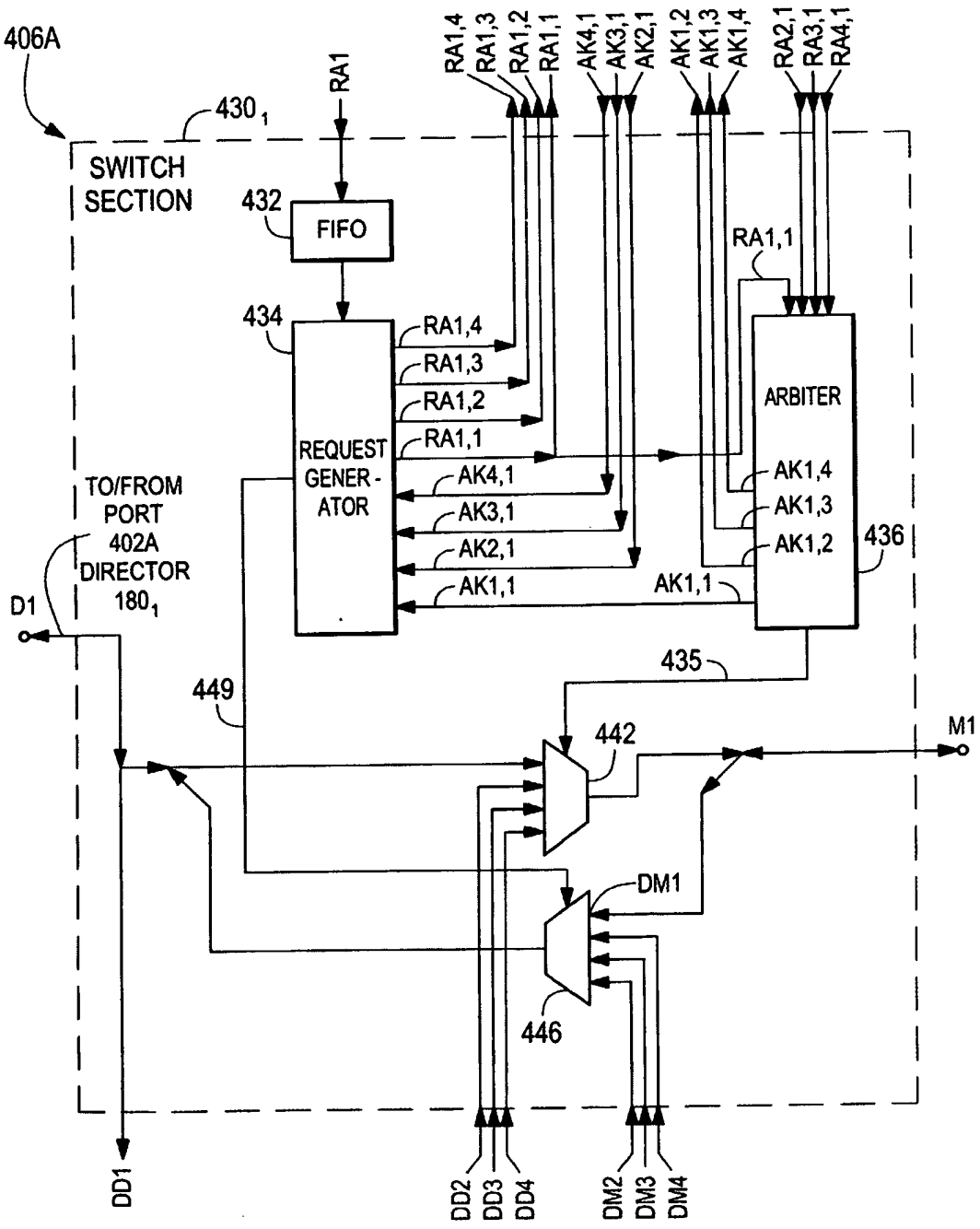


FIG. 8C-1

FIG. 8C

FIG. 8C-1
FIG. 8C-2

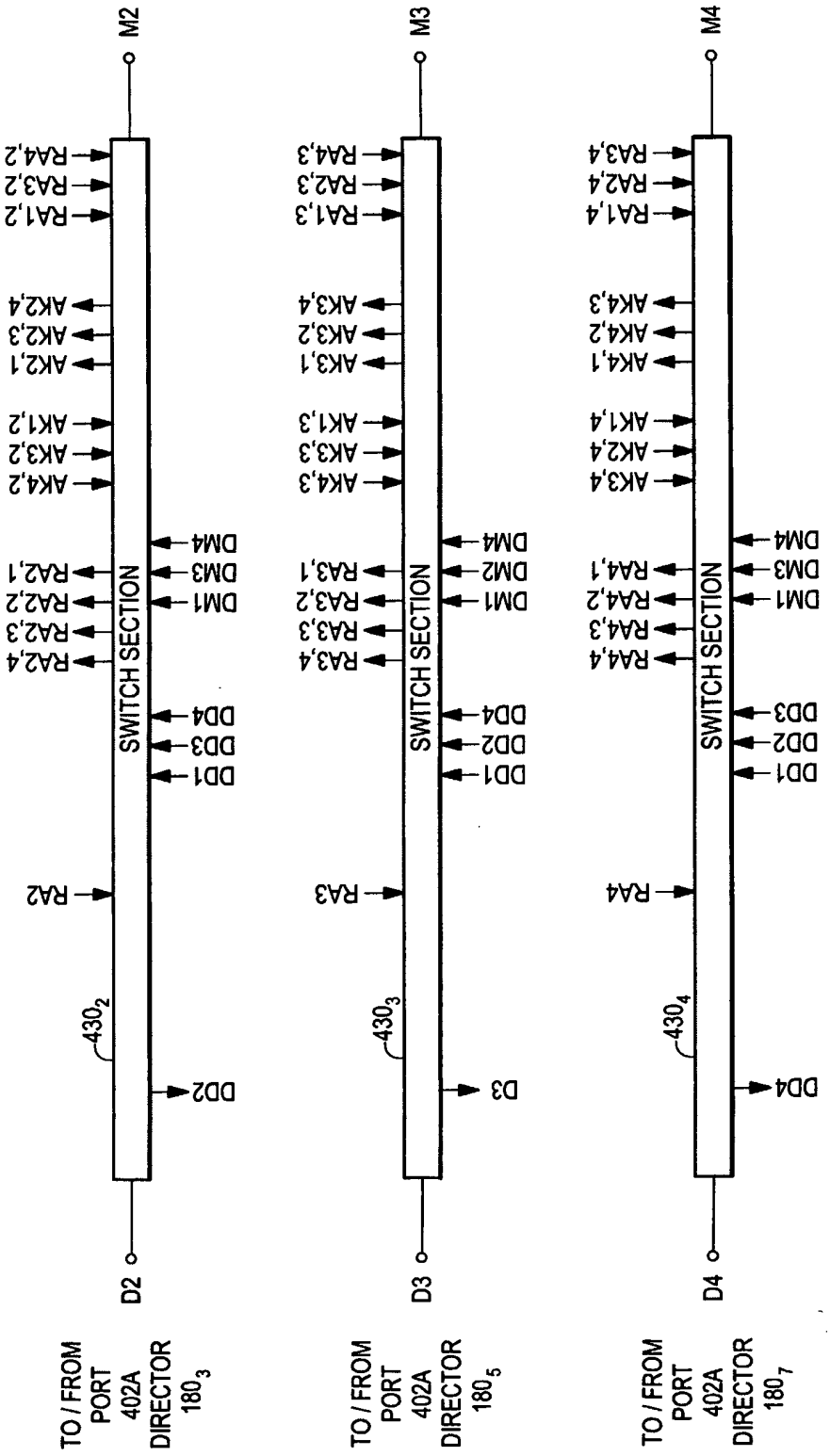

M2
M3
M4
RA4,2
RA3,2
RA1,2
AK2,4
AK2,3
AK2,1
AK1,2
AK3,2
AK4,2
DM4
DM3
DM1
RA2,1
RA2,2
RA2,3
RA2,4
DD4
DD3
DD1
RA2
430_2
DD2
SWITCH SECTION
D2
TO / FROM PORT 402A DIRECTOR 180_3
RA4,3
RA2,3
RA1,3
AK3,4
AK3,2
AK3,1
AK1,3
AK3,3
AK4,3
DM4
DM2
DM1
RA3,1
RA3,2
RA3,3
RA3,4
DD4
DD2
DD1
RA3
430_3
D3
SWITCH SECTION
D3
TO / FROM PORT 402A DIRECTOR 180_5
RA3,4
RA2,4
RA1,4
AK4,3
AK4,2
AK4,1
AK1,4
AK2,4
AK3,4
DM4
DM3
DM1
RA4,1
RA4,2
RA4,3
RA4,4
DD3
DD2
DD1
RA4
430_4
DD4
SWITCH SECTION
D4
TO / FROM PORT 402A DIRECTOR 180_7

FIG. 8C-2

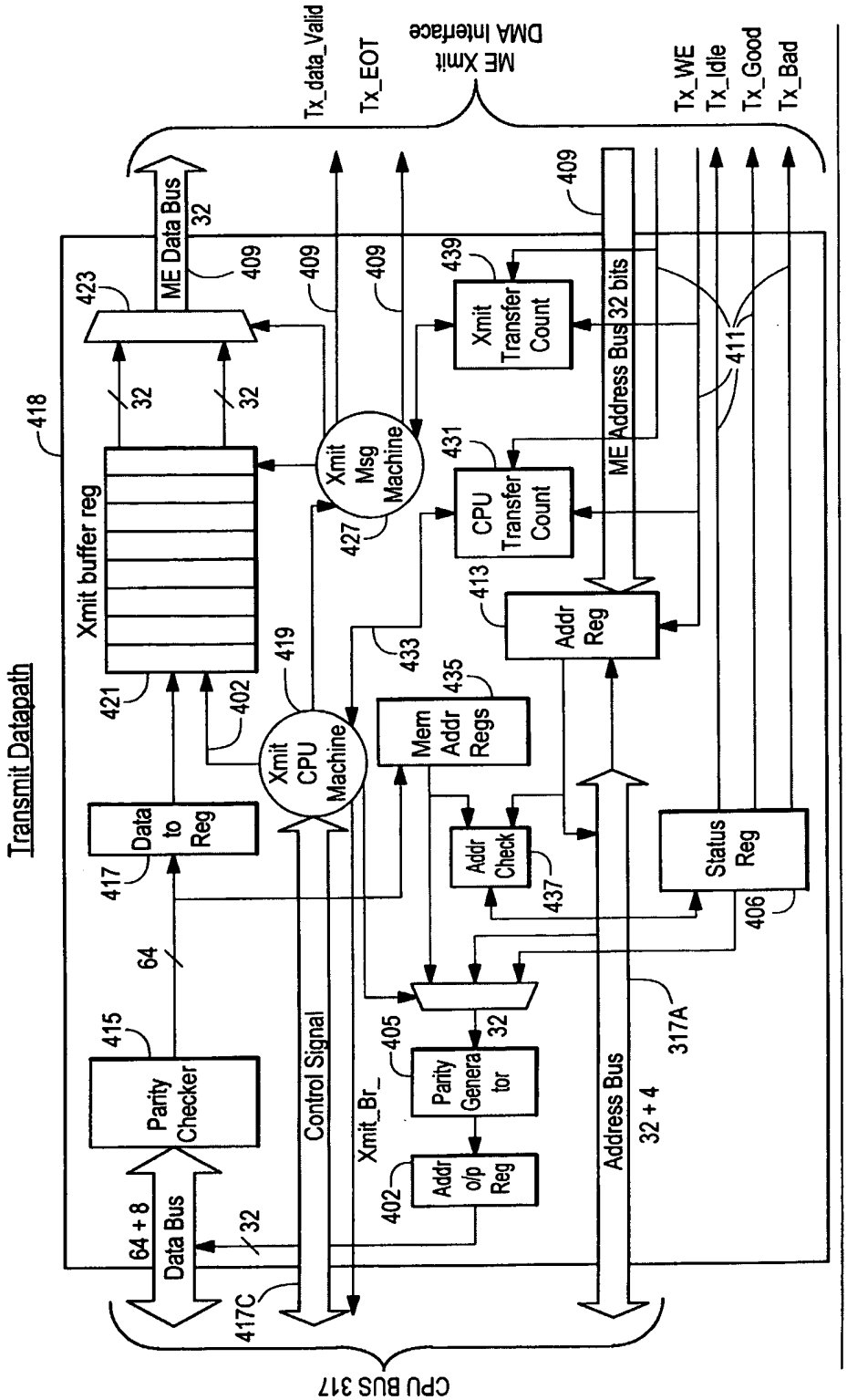

Transmit Datapath
418
Xmit buffer reg
421
402
423
ME Data Bus
32
409
Xmit Msg Machine
427
Xmit CPU Machine
419
Xmit Transfer Count
439
CPU Transfer Count
431
ME Address Bus 32 bits
411
Addr Reg
413
433
Mem Addr Regs
435
Addr Check
437
Status Reg
406
Data to Reg
417
64
Parity Checker
415
64 + 8 Data Bus
417C
Control Signal
Xmit_Br_
Parity Genera tor
405
Addr o/p Reg
402
Address Bus
32 + 4
317A
Tx_data_Valid
Tx_EOT
ME Xmit DMA Interface
Tx_WE
Tx_Idle
Tx_Good
Tx_Bad
CPU BUS 317

FIG. 9

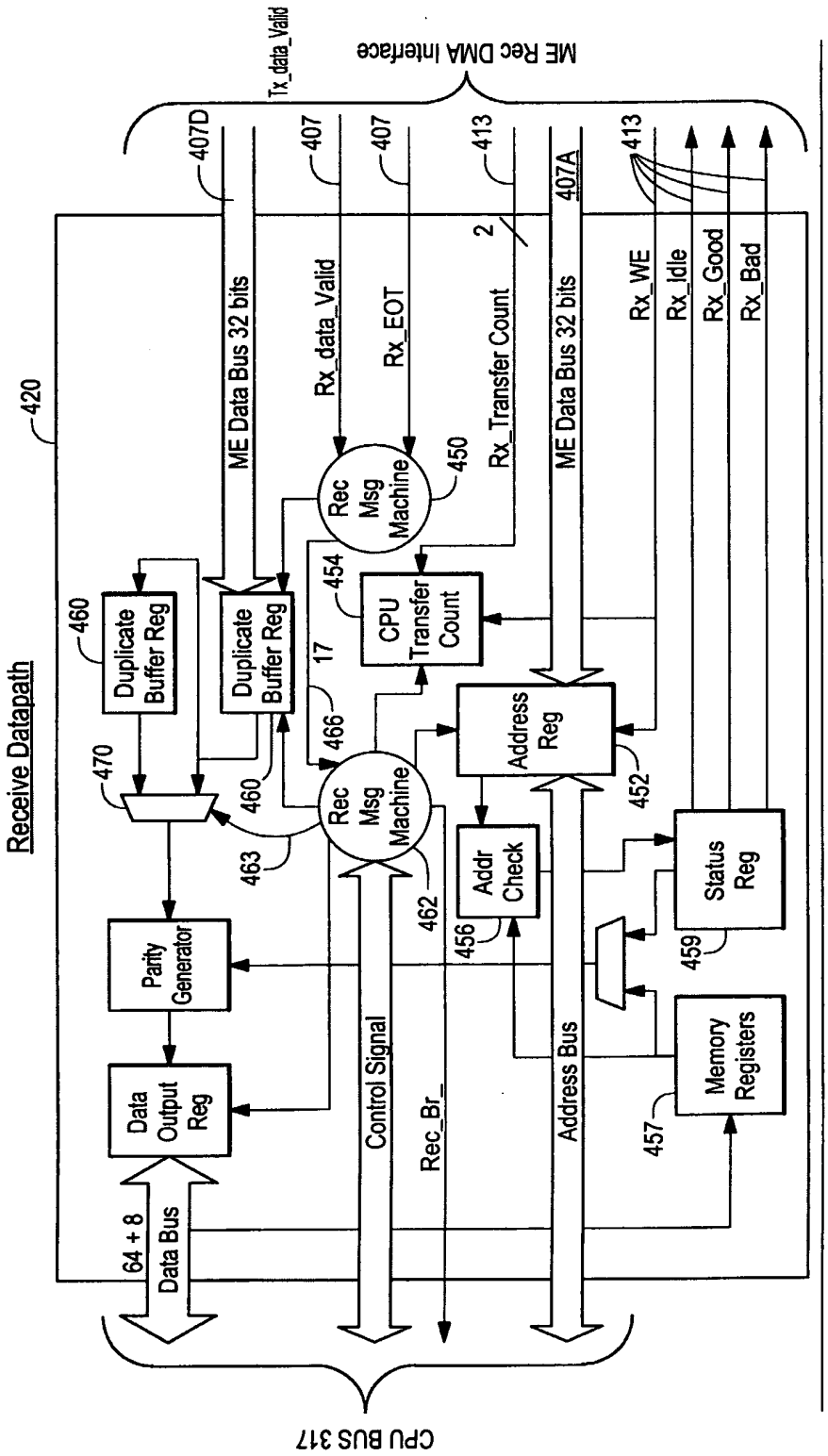

ME Rec DMA Interface
Tx_data_Valid
407D
407
407
413
413
407A
2
ME Data Bus 32 bits
Rx_data_Valid
Rx_EOT
Rx_Transfer Count
ME Data Bus 32 bits
Rx_WE
Rx_Idle
Rx_Good
Rx_Bad
420
Receive Datapath
Rec Msg Machine
450
454
CPU Transfer Count
460
Duplicate Buffer Reg
Duplicate Buffer Reg
17
466
Address Reg
452
470
460
Rec Msg Machine
463
462
Addr Check
456
Status Reg
459
Parity Generator
Data Output Reg
64 + 8 Data Bus
Control Signal
Rec_Br_
Address Bus
Memory Registers
457
CPU BUS 317

FIG. 10

FIG. 11

FIG. 11A

FIG. 11B

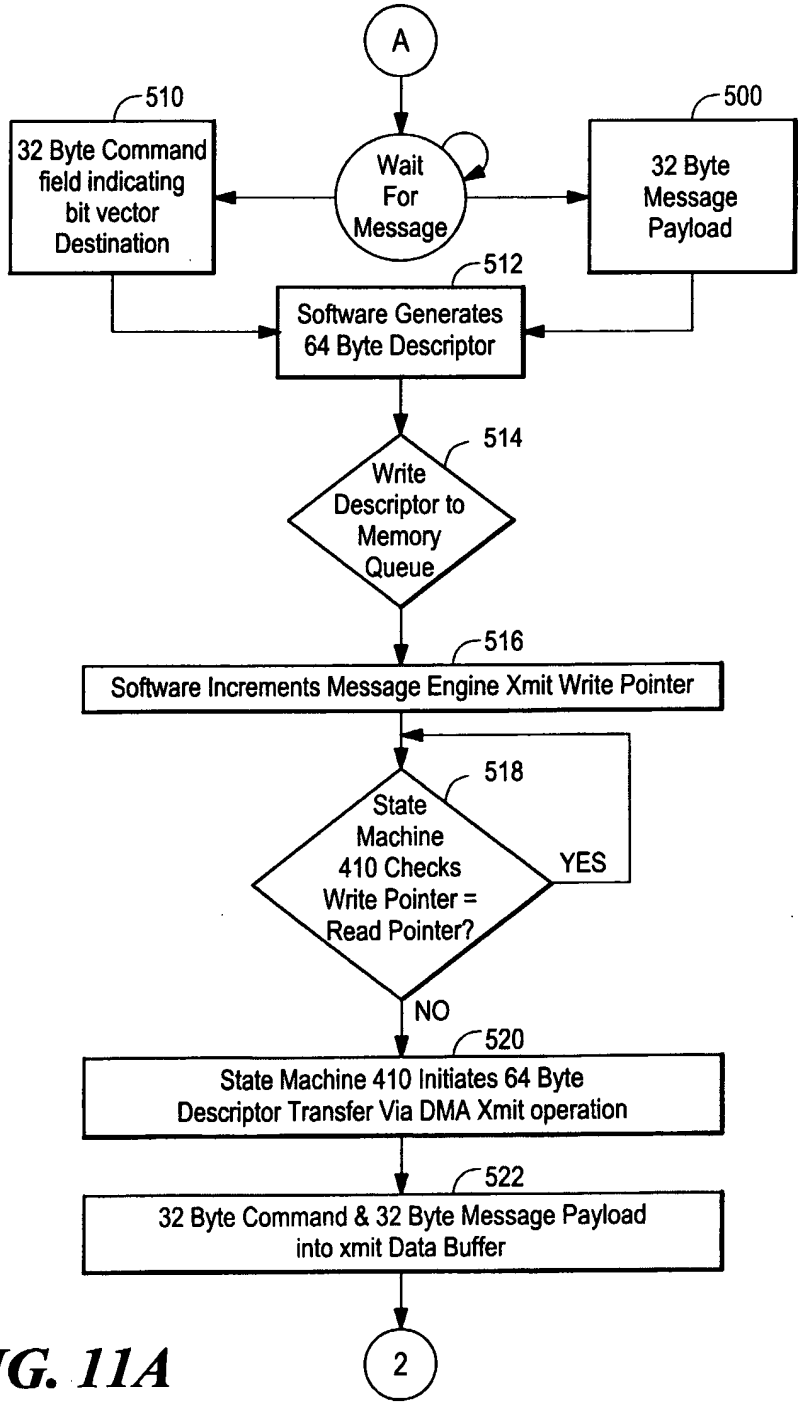


FIG. 11A

Message Bus Send Operation Continued

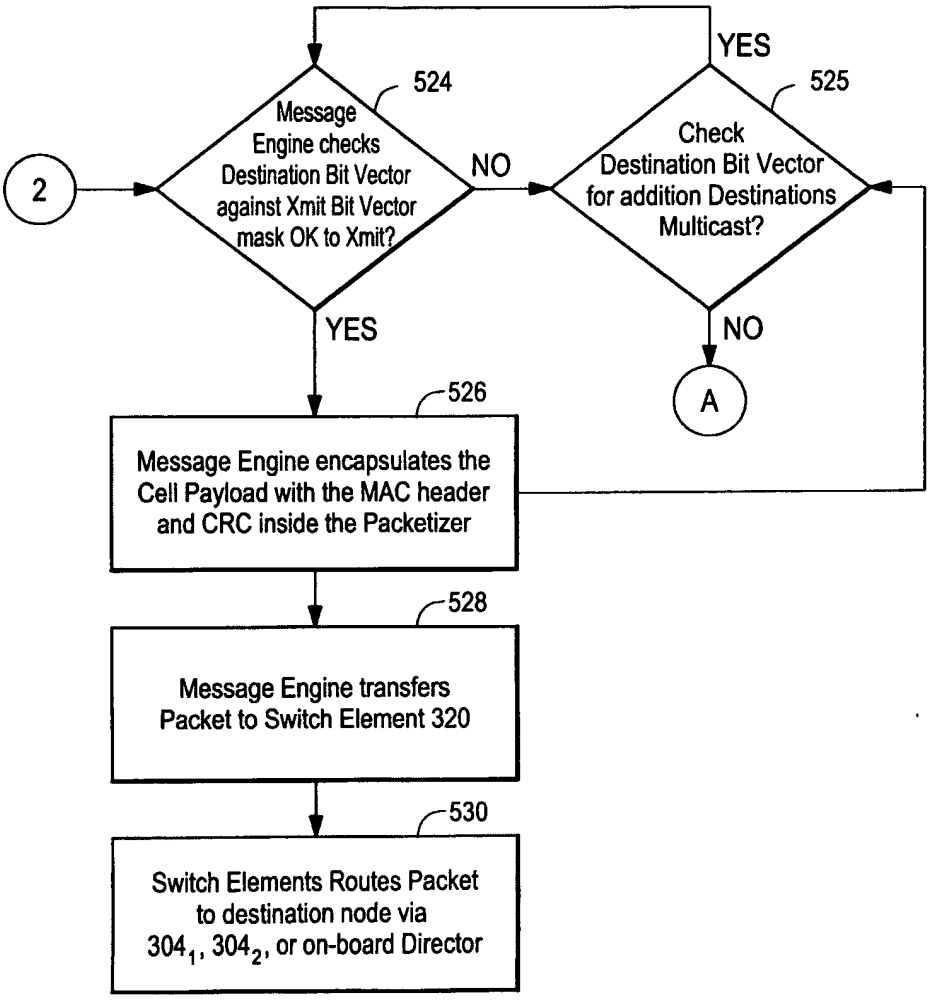


FIG. 11B

FIG. 11C

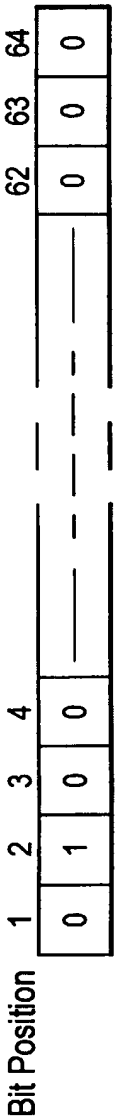


FIG. 11D

FIG. 11E

FIG. 11F

FIG. 11G

FIG. 12

FIG. 12A

FIG. 12B

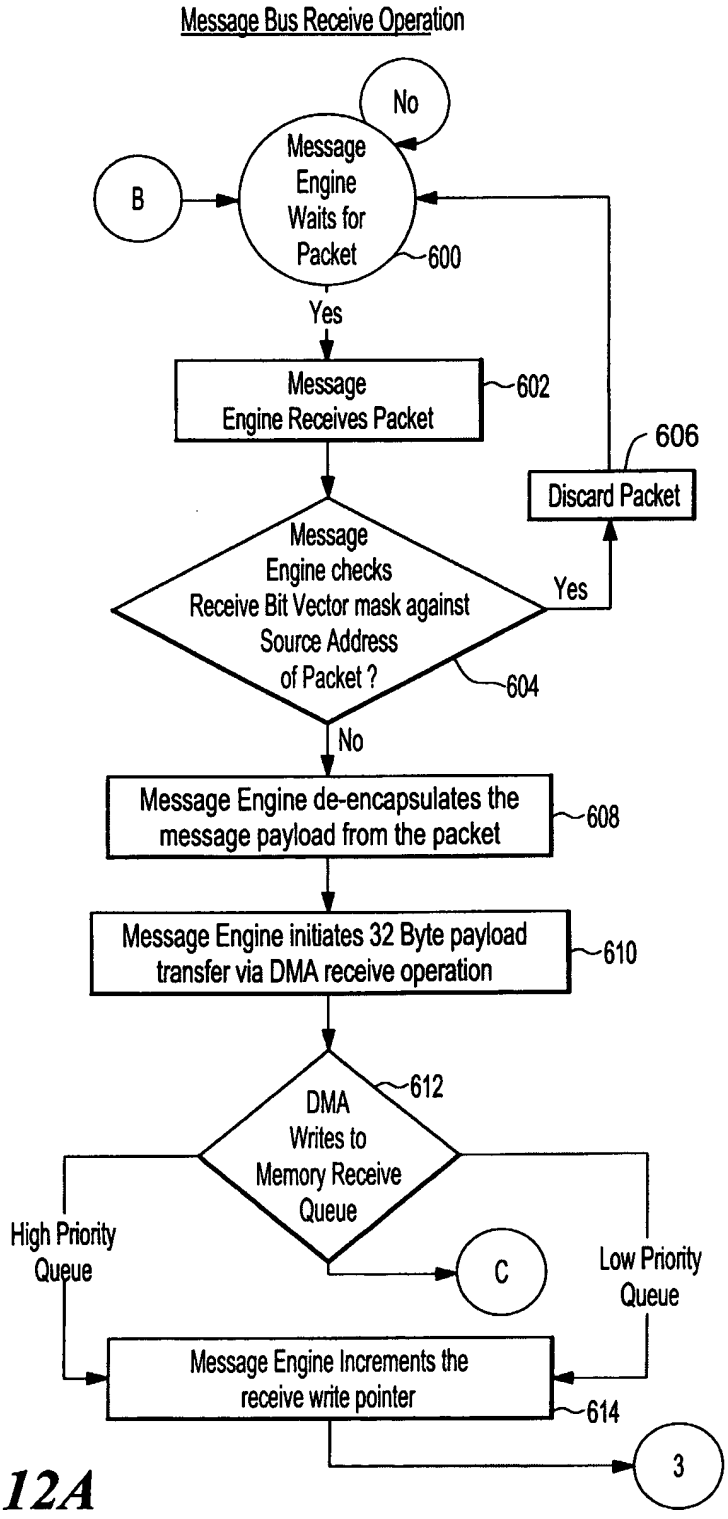


FIG. 12A

Message Bus Receive Operation Continued

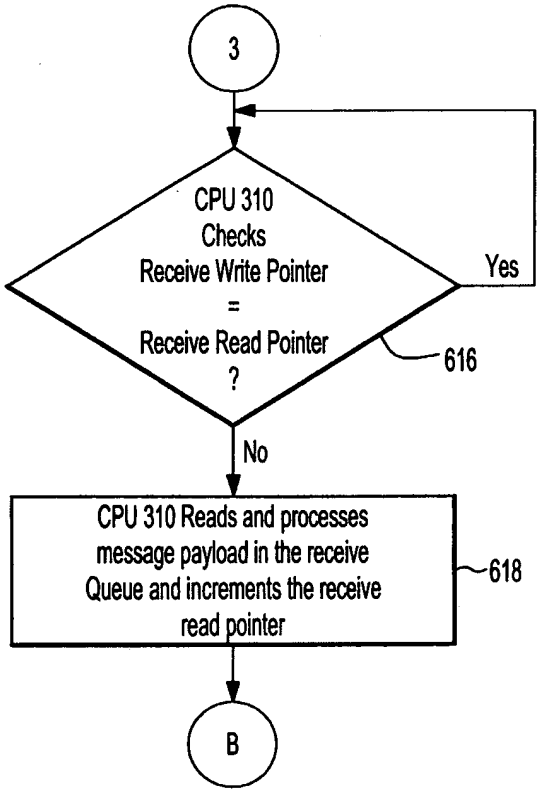


FIG. 12B

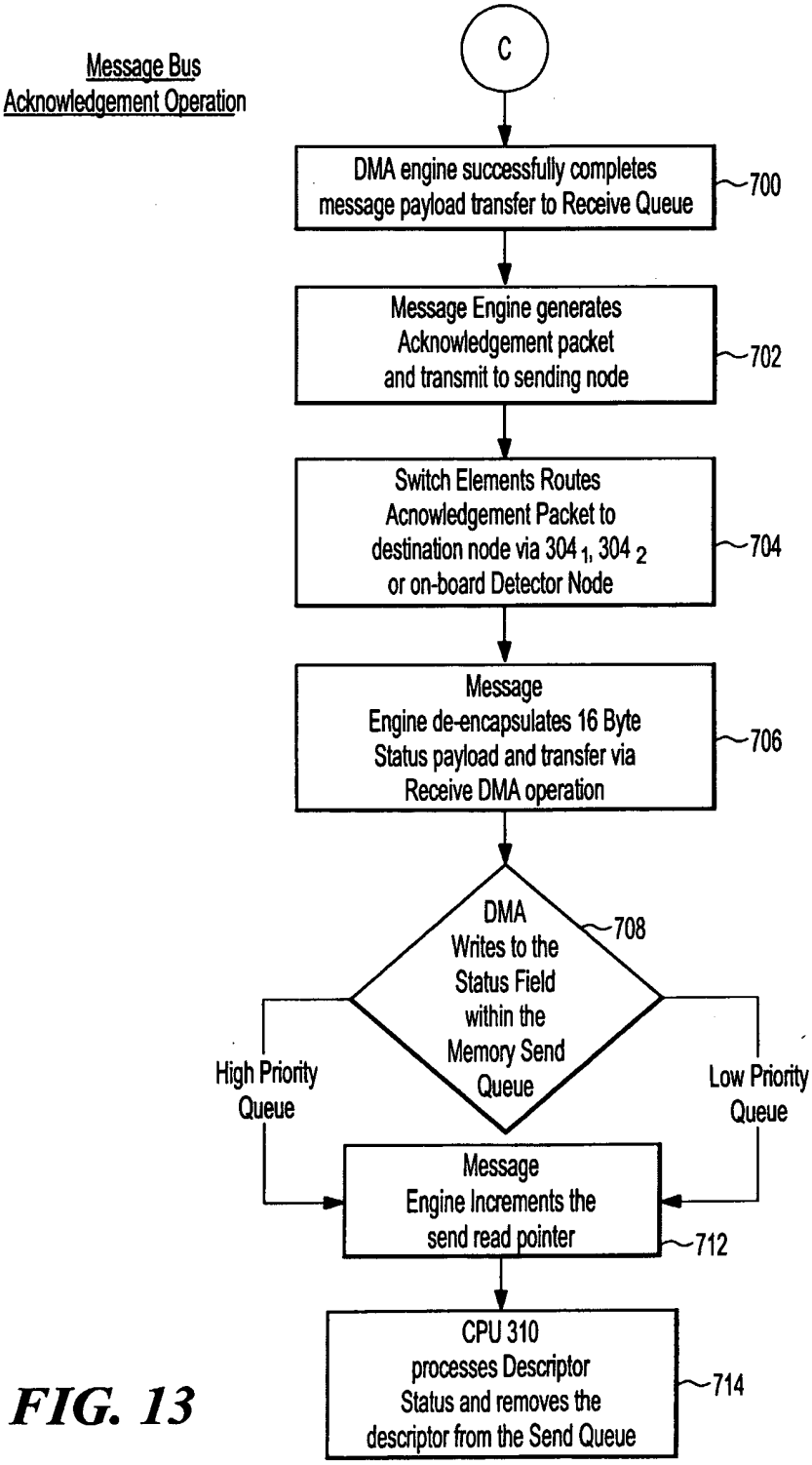

Message Bus
Acknowledgement Operation
C
DMA engine successfully completes message payload transfer to Receive Queue
700
Message Engine generates Acknowledgement packet and transmit to sending node
702
Switch Elements Routes Acnowledgement Packet to destination node via 304 1, 304 2 or on-board Detector Node
704
Message Engine de-encapsulates 16 Byte Status payload and transfer via Receive DMA operation
706
DMA Writes to the Status Field within the Memory Send Queue
708
High Priority Queue
Low Priority Queue
Message Engine Increments the send read pointer
712
CPU 310 processes Descriptor Status and removes the descriptor from the Send Queue
714

FIG. 13

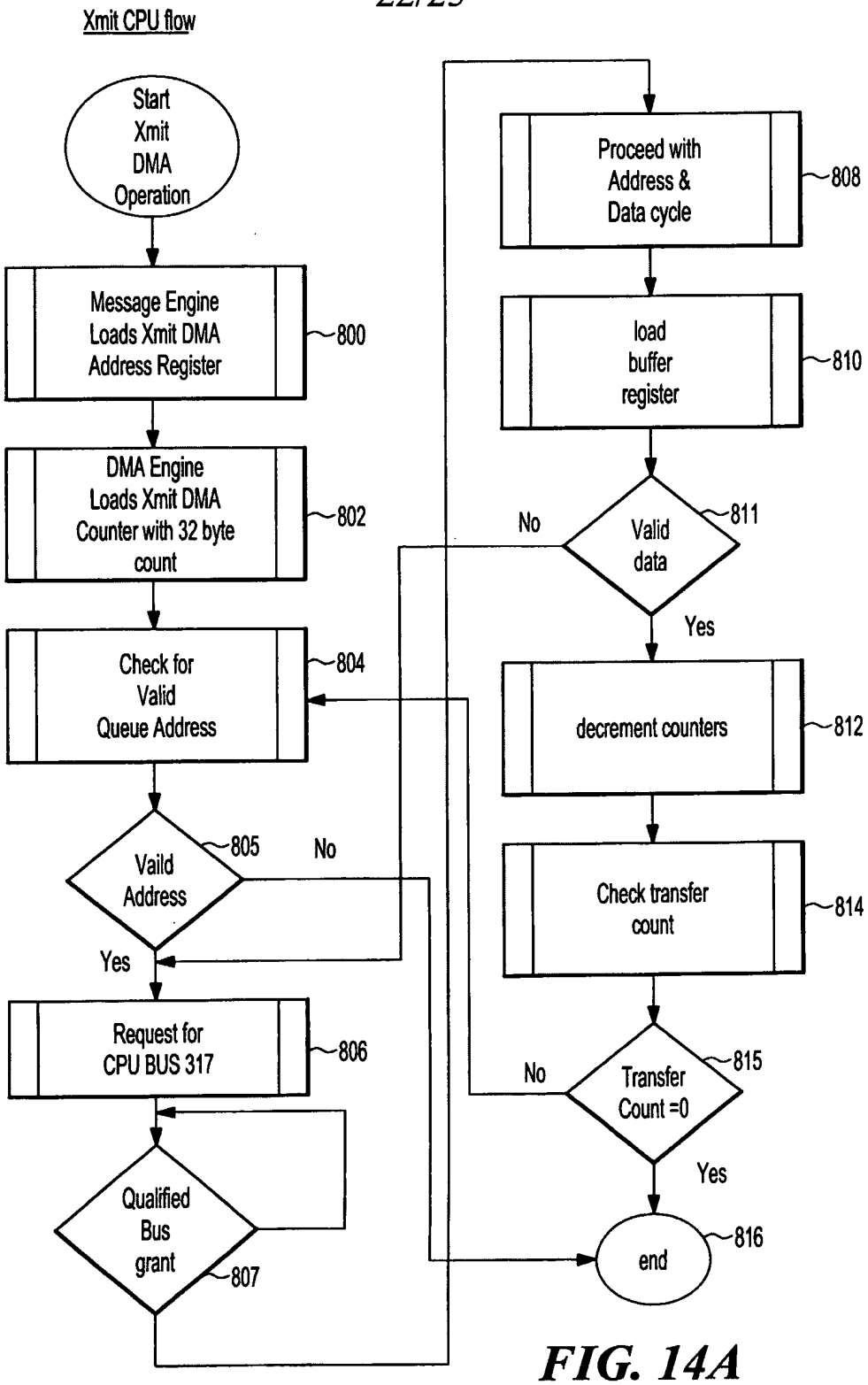

Xmit CPU flow
Start Xmit DMA Operation
Message Engine Loads Xmit DMA Address Register
800
DMA Engine Loads Xmit DMA Counter with 32 byte count
802
Check for Valid Queue Address
804
Vaild Address
805
No
Yes
Request for CPU BUS 317
806
Qualified Bus grant
807
Proceed with Address & Data cycle
808
load buffer register
810
Valid data
811
No
Yes
decrement counters
812
Check transfer count
814
Transfer Count =0
815
No
Yes
end
816

FIG. 14A

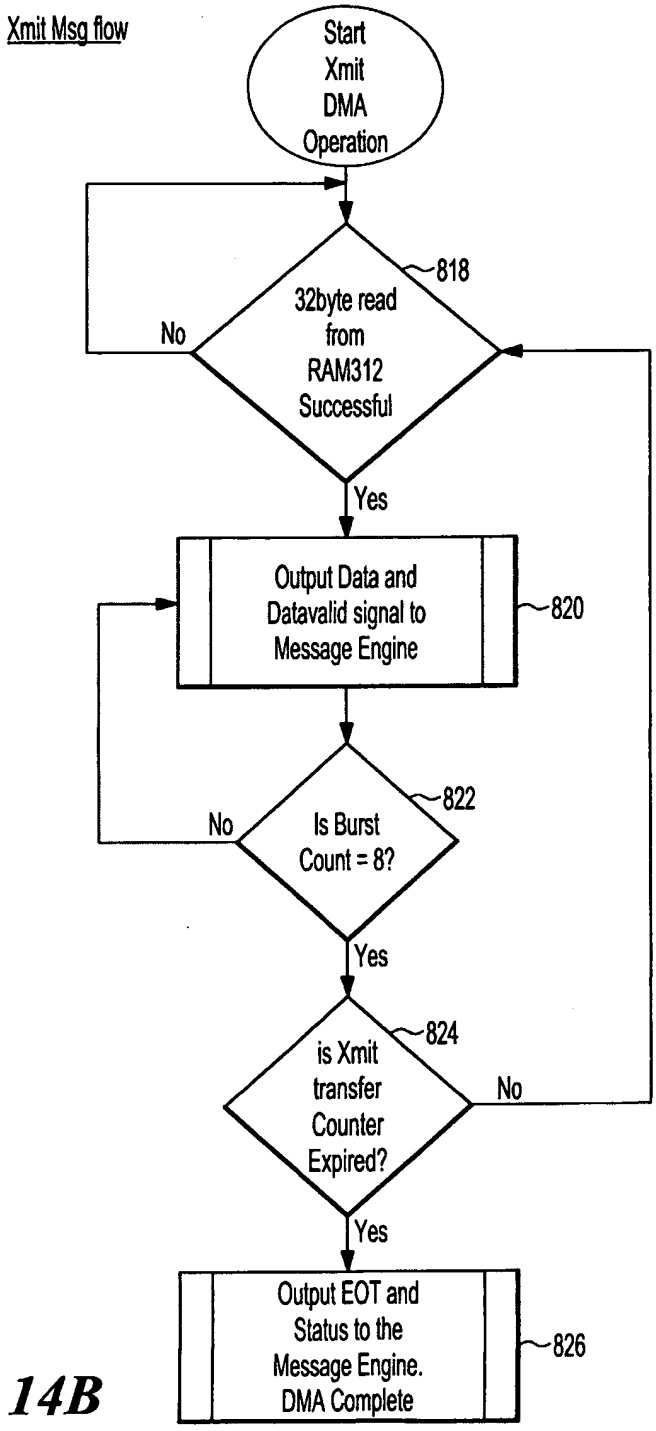

Xmit Msg flow
Start Xmit DMA Operation
818
32byte read from RAM312 Successful
No
Yes
Output Data and Datavalid signal to Message Engine
820
822
Is Burst Count = 8?
No
Yes
824
is Xmit transfer Counter Expired?
No
Yes
Output EOT and Status to the Message Engine. DMA Complete
826

FIG. 14B

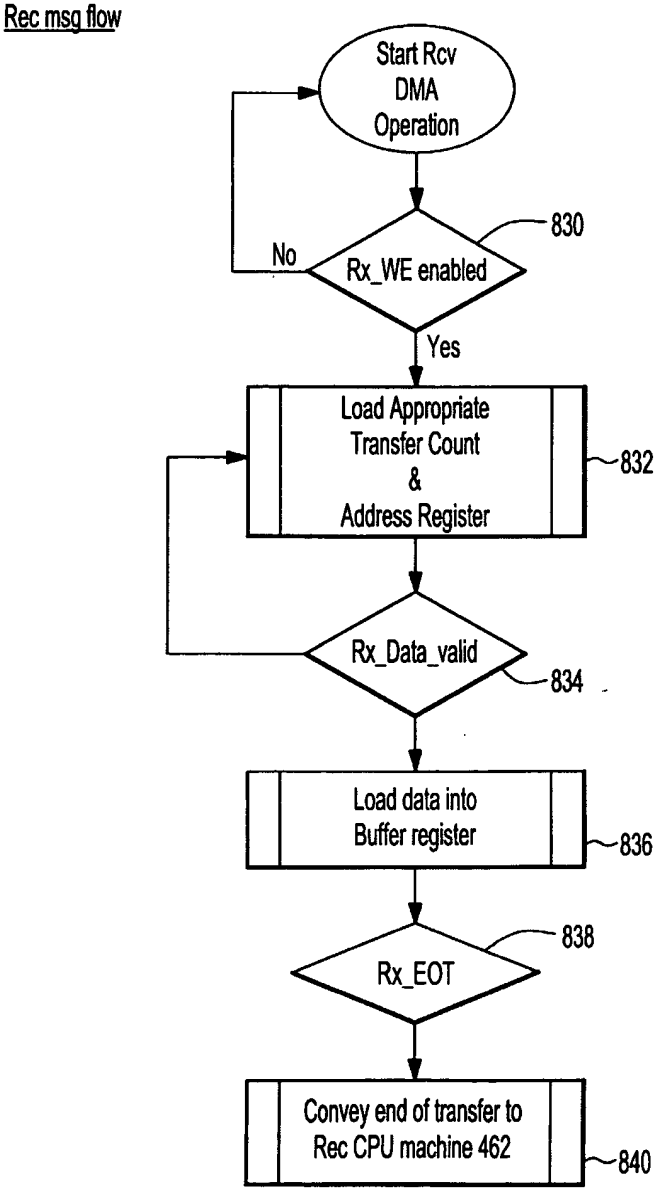

Rec msg flow
Start Rcv DMA Operation
830
No
Rx_WE enabled
Yes
Load Appropriate Transfer Count & Address Register
832
Rx_Data_valid
834
Load data into Buffer register
836
838
Rx_EOT
Convey end of transfer to Rec CPU machine 462
840

FIG. 15A

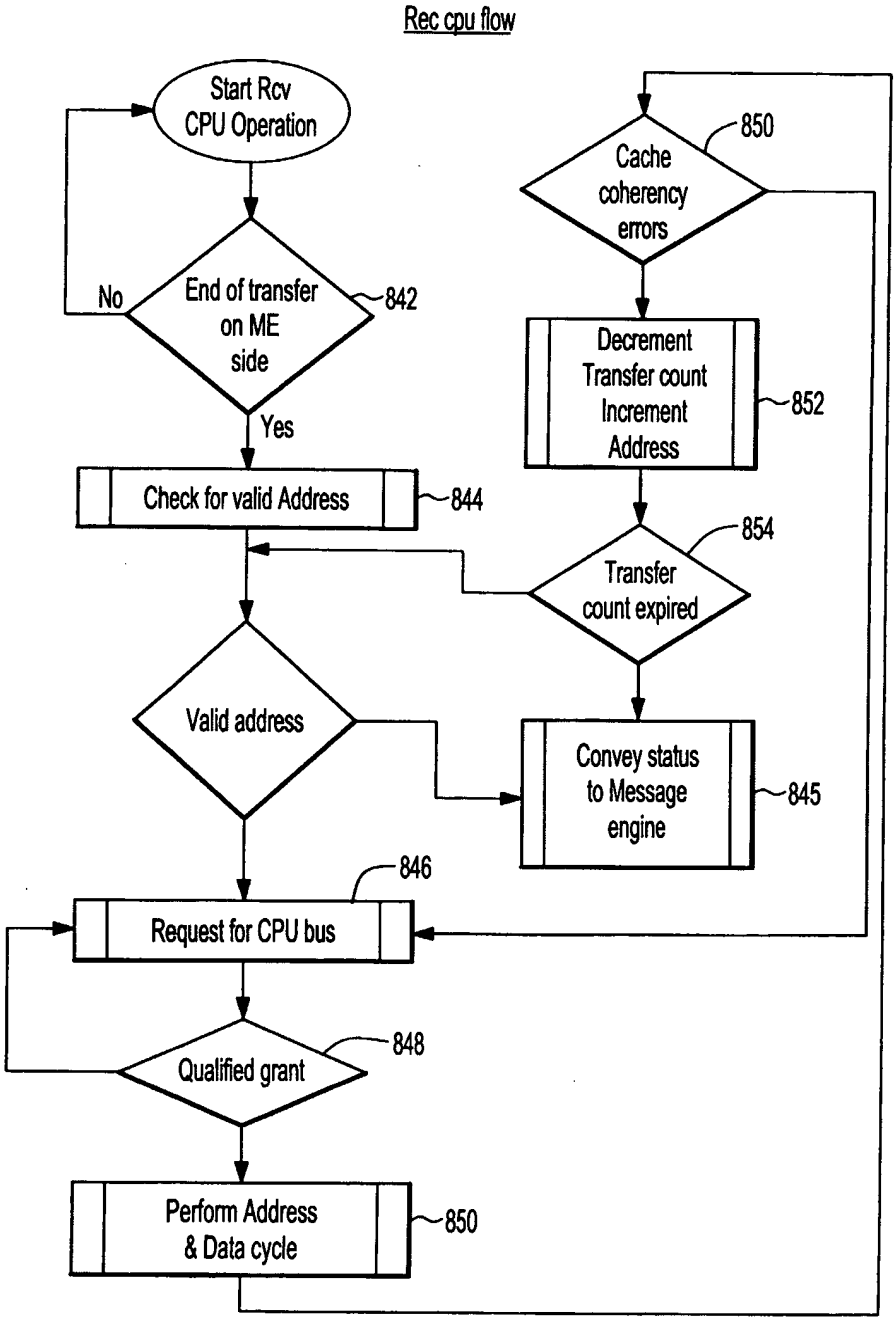

Rec cpu flow
Start Rcv CPU Operation
End of transfer on ME side
No
Yes
842
Check for valid Address
844
Valid address
Request for CPU bus
846
Qualified grant
848
Perform Address & Data cycle
850
Cache coherency errors
850
Decrement Transfer count Increment Address
852
Transfer count expired
854
Convey status to Message engine
845

FIG. 15B